METHOD AND DEVICE FOR BIDIRECTIONAL COMMUNICATION BETWEEN AT LEAST TWO COMMUNICATION DEVICES

[Background Information] FIELD OF THE INVENTION

The present invention relates to a method and a device for providing bidirectional data transmission between at least two communication devices [according to the preambles of the independent claims. In particular,] including data [is] transmitted between a peripheral device and a controller in an airbag system.

BACKGROUND INFORMATION

In this regard, German Published Patent Application No. 196 09 290 [A1 describes] discusses an airbag system for protecting the occupants of a vehicle. [This provides for a] A plurality of sensor modules [which are] may be connected via pairs of lines to a controller [situated] arranged at a distance. The controller [controls] may control a restraint device for vehicle occupants such as an airbag [in particular], for example. The output signals of the sensor modules [are] may be transmitted to the controller in the form of sequential changes in the current flow on both lines, i.e., in the form of analog push-pull signals or in the form of a pulse train. In the opposite direction, namely from the controller to the sensor modules, the data [is] may be implemented by sequential changes in voltage. The communication [takes place] occurs with a time offset, i.e., the controller [signals] may signal the start of transmission to the sensor modules on the basis of a request signal in the form of sequential changes in voltage, and following that in the opposite direction, i.e., from the sensor modules to the controller, data [is] may be transmitted in the form of sequential changes in current flow via the line pair.

With regard to the current interface, [i.e., usually] wherein the direction of transmission may flow from the sensor modules to the controller, German Published Patent Application [198 13 965.9 (not a prior publication), describes] No. 198 13 965, discusses a method of transmitting digital data with a clock acceptance generator whose clock frequency [is] may be controllable. Data transmission from a peripheral device to a controller [by] via signal edges of the current flow in a special shape [is] may be described here. The coding of the binary states [is] may thus be defined by a rising or a falling signal edge, which [must] may need to be detected in a certain time window. Through the additional use of Manchester coding, the data acceptance clock generator frequency may be synchronized. The time shift, occurring here between the data pulses and the synchronization times of the pulse-edge changes [is], may be taken into account by a time-offset sampling of the logic levels of the data pulses. If a bidirectional transmission according to this method were used, a time-offset data transmission [would] may also have to be used here.

In addition to the Manchester or Manchester II coding mentioned above, there are other coding methods, in particular cyclic coding methods, [are also known] in data transmission technology, e.g., the Hamming code or the Abramson code, etc.

SUMMARY OF THE INVENTION

An object of an exemplary embodiment [The object] of the present invention [is to implement a refinement on the basis of the description of German Patent Application 198 13 965.9 (not a prior publication), to the extent that] involves providing simultaneous bidirectional data transmission in both directions [is possible], in addition to the current interface [described there.]referred to in German Published Patent Application No. 198 13 965.

[Advantages] An exemplary embodiment and/or exemplary method

of the [Invention

The] present invention [is based on] <u>concerns</u> a method [and] <u>and/or</u> a device for <u>providing</u> bidirectional data transmission between at least two communication devices[, the]<u>. The</u> data transmission [being] <u>may be</u> implemented by changes in current flow in one communication direction and by changes in voltage in the other communication direction<u>. Thus</u>, data transmission [being achievable] <u>may be achieved</u> simultaneously in both communication directions on one communication path. In particular, <u>the exemplary embodiment and/or exemplary method of</u> the present invention [improves upon the content of]<u>(in contrast to</u> German <u>Published</u> Patent Application [198 13 965.9 (not a prior publication), to the extent] <u>No. 198 13 965)</u> <u>provides</u> that a bidirectional and simultaneous data transmission [is possible] <u>may be done</u> in both communication directions. [Thus, the content of] <u>The</u> German <u>Published</u> Patent Application 198 13 [965.9 is also included in the content of the present invention presented here.] <u>965 is incorporated by reference, as necessary.</u>

[Due to the fact that] <u>Since</u> communication from the first communication device, in particular a peripheral device, to the second communication device, in particular a controller, [is] <u>may be</u> implemented [by] <u>via</u> signal edges of the current flow, while the change in voltage levels [represents] <u>may represent</u> communication from the controller to the peripheral device, transmission from communication device 1 to communication device 2, i.e., from the peripheral device to the controller [being]<u>(which may be</u> implemented according to the [above] German <u>Published</u> Patent Application [(not a prior publication)] <u>referred to above)</u>, a rapid digital data transmission from the peripheral device to a controller [is] <u>may be</u> achieved with its characteristic advantages, and in addition, the bidirectional capability of the interface [is] <u>may be</u> achieved by sampling the change in potential on the

connecting line.

The Manchester code[,] (in particular, for example, the Manchester II code[,]) may be [accepted to advantage] used for encoding the digital information in both communication directions. This [makes it possible to increase] should allow for increasing the data rate through self-synchronizing encoding of the digital data for communication in both directions.

[It is advantageous that data] Data transmission from communication device 2, i.e., the controller, to communication device 1, i.e., the peripheral device, [is] may be implementable through any desired coding, i.e., for example the Hamming code or the Abramson code, etc. in addition to the Manchester or Manchester II codes.

The exemplary interface according to the present invention may [advantageously] permit operation of the interface according to ISO Standard 9141 through a [simple] variation in the components used (component variant).

When using Manchester coding, synchronization [takes place] may occur in the middle of a pulse, in particular a data pulse, and [is thus advantageously always possible and] thus may be precise due to the pulse edge change occurring there. In Manchester coding, the period of time between two synchronization times in the middle of the pulse [is advantageously] may be used as the time range representing the clock frequency. [Due to the fact that the] The clock frequency [is] may be detected by [the essentially known] counting [of] the oscillator clock pulses and the data acceptance generator [accepts] may accept the prevailing clock frequency in the current middle of the pulse[, but the]. The data acceptance generator, however, [detects] may detect the pulse levels with a time offset, so it [adjusts] may adjust to

these levels [to advantage.] in an advantageous way. To [be able to] utilize one-bit error detection, [which is another advantage of Manchester coding,] the two halves of each pulse [are] may be appropriately sampled at least once in the middle of the pulse before and after the synchronization time. Sampling [is advantageously] may be performed by multiple sampling within one sampling window. Thus, the advantages with regard to the direction of communication from peripheral device to controller [are] may be preserved [completely] and may also be utilized in the opposite direction at the same time.

Thus, in general, simultaneous bidirectional data transmission by both communication devices [is possible to advantage, preferably asynchronously.] may be provided, including, for example, asynchronously.

[Other advantageous embodiments are derived from the description and claims.] BRIEF DESCRIPTION OF THE DRAWINGS [Drawing

Figure 1 shows a possible basic design of a] Figure 1 shows an exemplary device for data transmission according to the present invention.

Figure 2 shows [in principle] a timing sequence of data transmission from communication device 2[,] (i.e., the controller[,]) to communication device 1[,] (i.e., the peripheral device). The transmission is indicated with an intermediate level and also with a true low level by turning it on and off.

[Transmission of data from communication device 1 to communication device 2 is described in German Patent Application 198 13 965.9 (not a prior publication), the content of which is also included here.] DETAILED DESCRIPTION

[Description of the Exemplary Embodiments

Figure 1 shows the basic design] Figure 1 shows a configuration of the interface, 101 representing a switching logic circuit or semiconductor intelligence, in particular in the form of a microcontroller, etc. At least one peripheral device 100 is connected to switching logic circuit 101. Switching logic circuit 101 having at least one peripheral device 100 forms a communication device K1, for example. A controller may also be provided as communication device 1. Line 114 is the output line from switching logic circuit 101. Line 115 is the input line leading to switching logic circuit 101. Switching logic circuit 101 is connected by line 114 to a consumer 102 which is in turn connected to a switching [means] arrangement 105, in particular a transistor. Switching [means] arrangement 105 is connected to ground and to another consumer 104. Consumer 104 is connected to another consumer 106, which is in turn connected to ground. Another consumer 109 is connected to consumer 104 and consumer 106. On the opposite side, consumer 109 is connected to a potential at pin 108, in particular power supply voltage UBAT. A power storage device, in particular a capacitor 110 which is also connected to ground, is connected to the common potential point of three consumers 104, 106 and 109. The common potential point or common line segment of consumers 104, 106 and 109 as well as power storage device 110 are connected to a comparator 103. A pin 107 is also provided in comparator 103, and a potential VC is applied to it. Comparator 103 is connected at the output to switching logic circuit 101 by line 115. The components and connecting lines described above are parts of periphery P according to the present invention. [This periphery] Periphery P is connected to controller area S via transmission line T. Transmission line T begins in peripheral port Pp, which is connected to comparator 103 via the common line segment described above. The connection of controller area S, i.e., the connection to transmission line T, i.e., the controller

port, is labeled as Ps. Transmission line T is connected via port Ps via line 118 to communication device K2 and at the same time to a consumer 111. Consumer 111 is also connected to communication device K2 via a line 117. A power storage device, in particular a capacitor 112, is also connected to line 117 and to ground at the same time. Communication device K2 contains an analyzer circuit or analyzer logic circuit 113 or corresponding semiconductor intelligence in the form of a microcontroller, for example, and an actual microcontroller 116 of a controller. However, [it is also conceivable for] analyzer circuit 113 and microcontroller 116 [to] may be accommodated in one integrated module. Thus, 116 may be only a microcontroller or it may be a complete controller, in which case logic circuit 113 may be swapped out.

The interface according to the present invention [requires] may require at least one electric connection T between periphery P and controller area S, which transmits data information in both directions. The reference potential, in particular ground, may be the reference potential of the controller via another electric connection [(not shown here)] or the reference potential may be with respect to another location near the periphery. Switching logic circuit 101 serially performs the pulse-edge control according to Manchester II coding, for output line 114 as well as performing the analysis and further processing of the serially applied voltage levels, e.g., in Manchester II coding, for example for input line 115. Output line 114 is thus the signal path for all data transmissions to the controller, while input line 115 connects the communication between periphery P and switching logic circuit 101.

In addition, switching [means] arrangement 105 is described as a bipolar transistor. However, switching [means] arrangement 105 may also have another [design] configuration, e.g., a unipolar transistor or another switching logic circuit. The

base of transistor 105 is controlled via consumer 102 as a voltage divider. If transistor 105 switches, then an increased current flow [is] may be made possible via transmission line T, the potential of transmission line T being maintained because of consumer 104. In addition, a residual current via transmission line T may be guaranteed via consumer 106 even in the closed state of transistor 105.

Power storage device 110 may be implemented as one or more protective capacitors, and [it contributes] may contribute toward smoothing the edges of the data transmission signal and reducing the emission of transmission line T. Comparator circuit 103 compares the potential of transmission line T with potential VC at pin 107 and thus transmits the coded digital message of controller area S via line 115 to switching logic circuit 101. A power supply voltage, in particular UBAT, i.e., the respective potential at pin 108 is injected via consumer 109.

On controller side S, logic circuit 113 may be implemented by an ASIC, for example. The typical potential on transmission line T is regulated by logic element 113.

If transistor 105 is switched, a voltage drops across consumer 111 and is analyzed between lines 117 and 118 or their inputs in logic element 113. Thus, logic element 113 may receive the coded digital message, processed according to Manchester II coding in particular, from periphery P to controller 9 and may process it further and optionally relay it to microcontroller 116. Power storage device 112 is a protective capacitor for protection from voltage injection or interference injection into logic element 113.

Logic element 113 has the capability through a corresponding control by microcontroller 116 to lower the potential of transmission line T to a residual potential, (e.g., >100 mV)

VTl or an intermediate potential VTlz and raise it back to the typical potential on transmission line T again. This change in potential on transmission line T may be applied at the peripheral side to switching logic circuit 110 via line 115 by comparator circuit 103 and the comparison of the potential of transmission line T with the potential at pin 107, VC. The output of comparator circuit 103 thus delivers to switching logic circuit 101 the coded digital message, in particular coded according to Manchester II, of the communication device, in particular a controller K2, and switching logic circuit 101 may then process it further.

Controller side S may be completely accommodated in the controller and likewise the controller may include only logic module 113 and microcontroller 116 in addition to other [known] components. Then the circuit of elements 111, 112, 117 and 118 [would] may be on the controller side but [would] may be upstream from the actual controller. Likewise, logic element 113 in the form of an ASIC in particular [could] may be upstream from the controller as communication partner K2. Due to this possible swapping out, which [is] may also be possible on peripheral side P, a transmission link which is independent of peripheral device 100 and controller or microcontroller 116 but is connectable to them may be implemented in one device.

The implementation of the interface illustrated in Figure 1 [corresponds] may correspond to the assembly variant addressed above according to ISO Standard 9141. An intermediate potential [is] may be achieved by terminal 108 and consumer 109 which injects its potential. This potential is thus between the residual potential at shutdown by switching [means] arrangement 105 and the potential on activation by switching [means] arrangement 105. This assembly variant yields an interface according to ISO Standard 9141, so that the interface shown here may be operated in accordance with

ISO 9141.

The other variant [is] may be obtained by omitting the branch having terminal 108 and consumer 109. Consumers 104 and 106 are dimensioned differently accordingly. Then, however, for simultaneous transmission on both sides, a charge pump, i.e., a power supply [must] may need to be available on both sides.

The timing of the interface is illustrated in Figure 2. Since the communication direction from periphery P to controller side S [is not adequately described in German Patent Application 198 13 965.9 (not a prior publication), and its content is also included in the present patent application] may not be sufficiently explicit in German Published Patent Application No. 198 13 965, possible implementations of the communication direction from controller side S to periphery P are illustrated in Figure 2. [Two possibilities are presented for implementation] Implementation of simultaneous transmission in both communication directions may be done, for example, in the following two ways.

As regards the transmission of data from communication device 1 to communication device 2, this may be obtained from German Published Patent Application No. 198 13 965.

The first one is an implementation having intermediate potential VTlz, illustrated in signal flow SPl with a one-sided power supply, i.e., on peripheral side P or controller side S of the transmission link, in particular through the branch described previously having terminal 108 and consumer 109.

The second [possibility] one is to provide separate power supplies for peripheral side P and controller side S if they do not obtain their power via electric connection T of the interface. Then it [is] may be necessary only to [guarantee]

ensure that the interface be repeatedly activatable and deactivatable.

Figure 2 shows potential VT on transmission line T plotted as a function of time. VTh shows a high potential and VTl shows the above-mentioned residual potential or low potential. An intermediate level VTlz, an intermediate low level, so to speak, is also illustrated at [possibility 1] the first one.

The activation operation applies a potential VTh at t1. The actual transmission of data is then represented by at least one start bit from t2 to t3 at time t2. In this diagram, Manchester II coding has again been selected, according to which synchronization [takes place] occurs in the middle of a pulse, making it possible to utilize [the advantages of] Manchester II coding for both communication directions. At time t3 there is then optionally another start bit or already the first data bit. Following that, additional data bits are transmitted at times t4 and t5. For example, a total of 8 data bits, i.e., one byte, may be transmitted per transmission frame. Following the data at time t6, then a parity bit for data checking is transmitted, and finally at time t7, a stop bit for frame limiting is transmitted.

The digital messages may be encoded according to Manchester II coding, as mentioned above, or according to other, in particular cyclic, codes such as the Hamming or Abramson codes.

The low level for SP1 here corresponds to an intermediate level which is less than high level VTh. This level VTlz at the same time [guarantees] may ensure an adequate current flow (not shown here) for the opposite direction [(not shown here)] from communication device 1 to communication device 2. Thus, one power supply on one side of the transmission link [is] may be sufficient.

In the second case, with power supplies on both sides of the transmission link, the signal is changed from low level VTl to high level VTh during activation operation at t11. Here again, at time t21, the transmission is begun at signal SP2, as in the case of SP1, with at least one start bit. At time t31, another start bit or the first data bit may be transmitted. Another data bit is transmitted at time t41. The remaining course corresponds to that of SP1, the difference being that the change between low potential VTl and high potential VTh is performed.

Since the current flow associated with low potential VTl in the opposite direction from K1 to K2 [is] may not be sufficient for data transmission, use of a separate power supply on peripheral side P and controller side S [is] may be necessary for a simultaneous transmission. Otherwise, i.e., in the case of SP2 without bilateral power supply, the interface [would] may be switched off at low level VTl and no communication [would] may be possible from the periphery to the controller, i.e., from K1 to K2 via changes in current flow. Thus, the communication directions [would] may have to be loaded with a time offset, so that communication [would take place] may occur with a time offset as in the related art.

In both cases SP1 and SP2, after termination of the communication, the level of transmission line T is again returned to high potential Vth with the stop bit at t7 or similarly with a stop bit at SP2[(not shown)].

Through the methods and devices presented here, it [is] may be possible to take into account the high requirements in the automotive field, regarding data security, data rate and cost of the system implementation in particular. In addition, [the] a possibility [is] may be created of detecting data failures during data transmission and compensating for them, in which

case a greater robustness with regard to electromagnetic compatibility effects [is] may also be achieved at the same time.

These methods and devices may be used, as mentioned above, independently of a specific application and in [all] cases where data transmission between at least two communication devices is desired. In addition to the airbag system mentioned here, other possible applications may include drive control, suspension and brake regulation as well as automatic transmission control operations, etc. Likewise, communication of other electronic devices such as door locks or window control with a controller [is] may also be included.

[Abstract] ABSTRACT OF THE DISCLOSURE

A method and a device for providing bidirectional data transmission between at least two communication devices is described, the data transmission in one communication direction being implemented by changes in current flow and in the other communication direction by changes in a voltage, the data transmission in both communication directions being implementable simultaneously on one communication path, one power supply being maintained for both communication directions through a steady minimum voltage level and/or minimum current flow level or a separate power supply being maintained for each communication device.